Bell Work
24-April-18

Please compute the " –log(7)" using your calculator?

What are acids and bases?

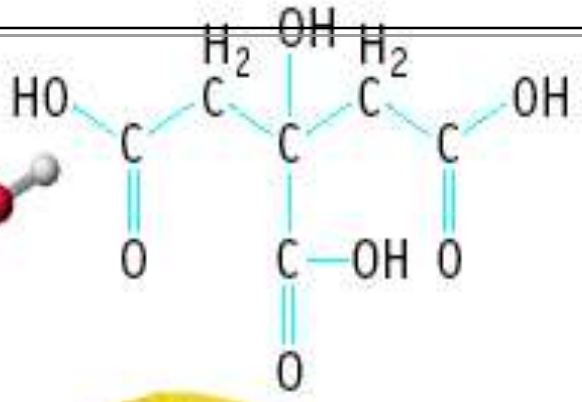
EQ: What bases have you used today and how did they help you?

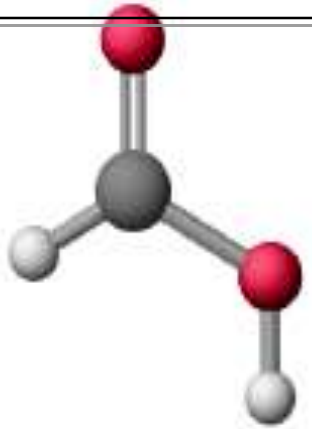
Agenda:
introduction to Acid Base Chemistry

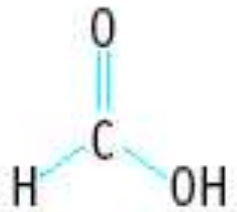
Objective:

Following the lesson you will be able to name simple acids and bases, know a general definition of an acid, and know how acids and bases taste

Acid and Bases



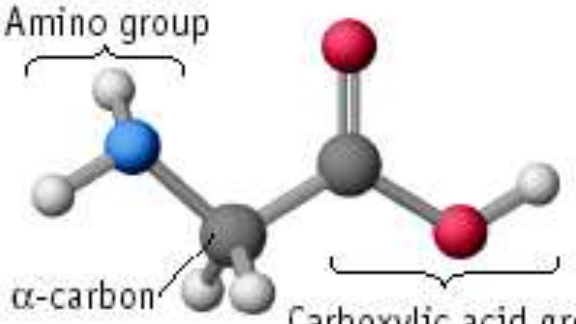




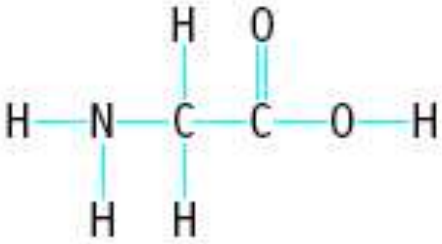
The tartness of lemons and oranges comes from the weak acid citric acid. The acid is found widely in nature and in many consumer products. *(Charles D. Winters)*

The sting of ants is due to the weak acid formic acid, HCO_2H. *(Gallo Images/@ CORBIS)*

Acid and Bases



Aspirin is a weak acid that has been used as an analgesic for over 100 years. *(Charles D. Winters)*

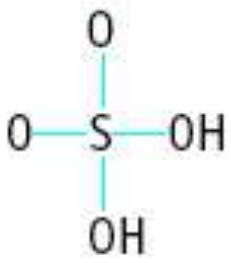


Glycine, $NH_2CH_2CO_2H$

Glycine is representative of the amino acids that are the basis of proteins. The $-CO_2H$ group is the acid portion of the molecule, and the $-NH_2$ group is the basic portion. *(Charles D. Winters)*

Acid and Bases

Caffeine is a well known stimulant and a weak base. *(Charles D. Winters)*



A sea slug excretes the strong acid sulfuric acid in self-defense. *(Sharksong/ M. Kazmers/Dembinski Photo Associates)*

Acids

Multiple definitions:

- Lewis
- Arrhenius
- Bronsted Lowry

Generally it's a chemical compound that produces a hydrogen ion concentration higher then pure water: $[H^+]$ or $[H_3O^+]$

Acids

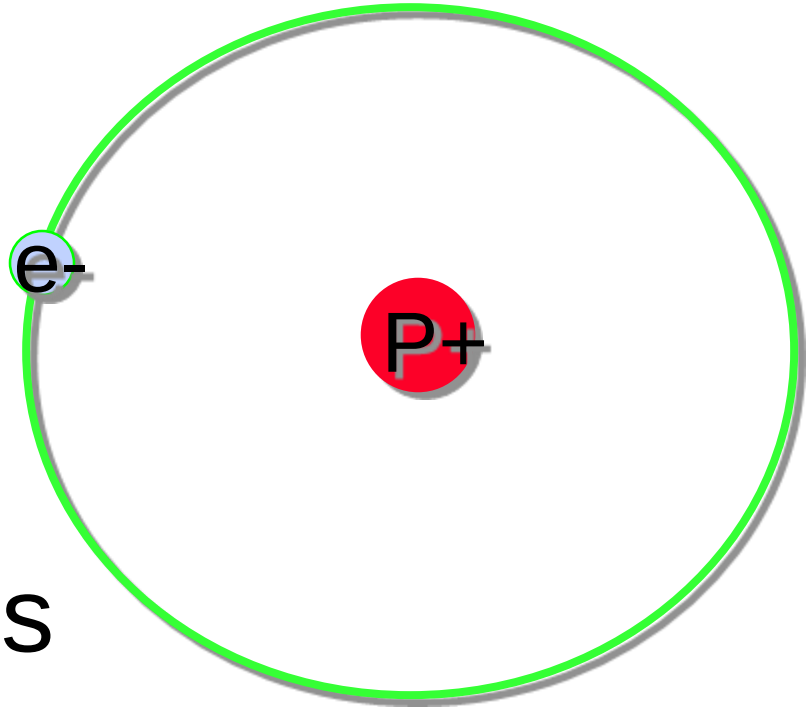
React with carbonates and bicarbonates to produce carbon dioxide gas

Have a sour taste. Vinegar is a solution of acetic acid. Citrus fruits contain citric acid.

Some Properties of Acids

Produce H^+ (as H_3O^+ ions in water):

Call a "proton"



Taste sour

Corrode metals

Acid Nomenclature Review

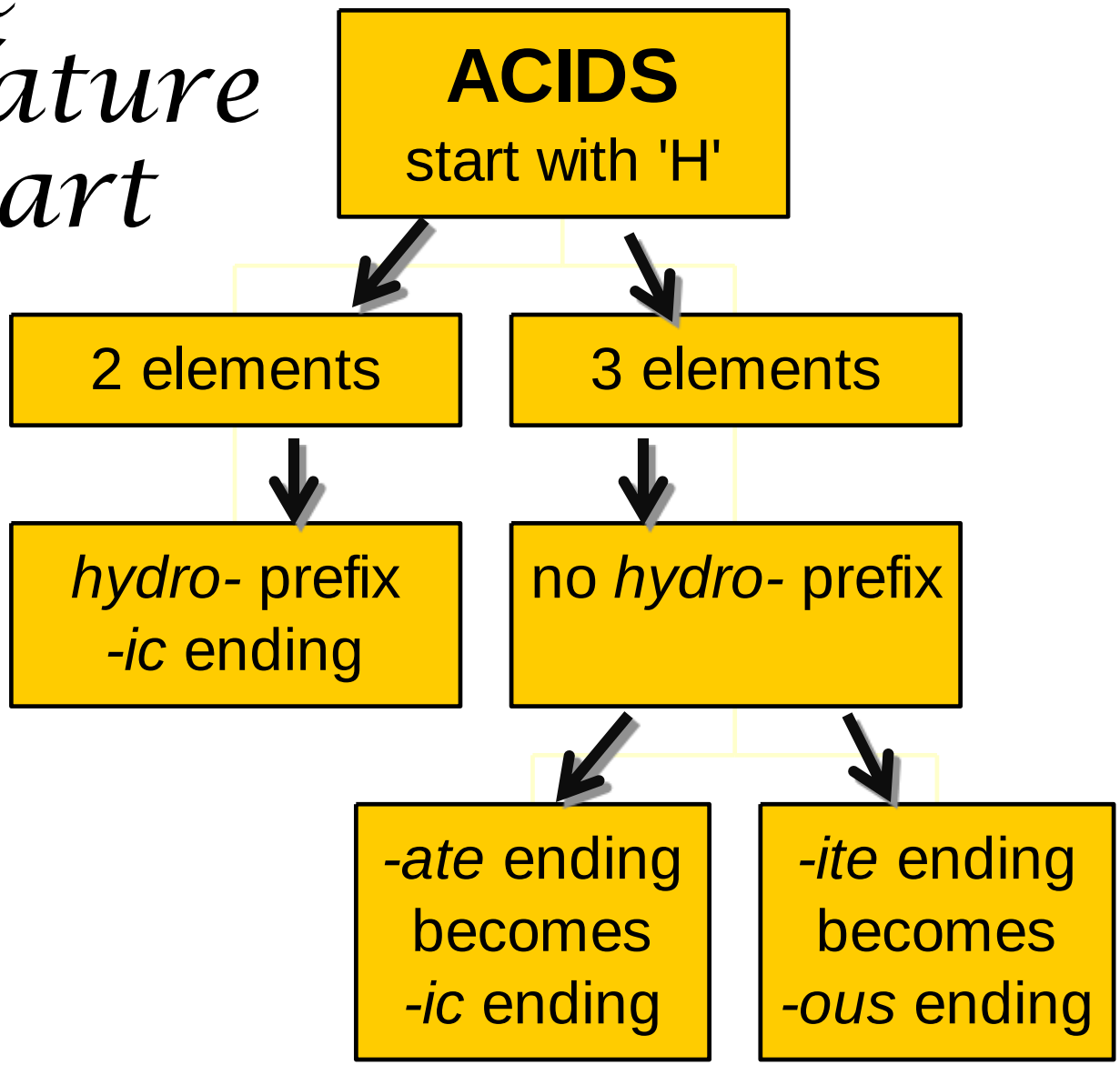
	Anion Ending	Acid Name
Binary →	*-ide*	*hydro-*(stem)*-ic acid*
Ternary	*-ate*	(stem)*-ic acid*
Ternary	*-ite*	(stem)*-ous acid*

Acid Nomenclature Review

An easy way to remember which goes with which…

"In the cafeteria, you ATE something ICky"

Acid Nomenclature Flowchart



Acid Nomenclature Review

$HBr_{(aq)}$ $\Rightarrow$ hydrobromic acid

H_2CO_3 $\Rightarrow$ carbonic acid

H_2SO_3 $\Rightarrow$ sulfurous acid

Strong Acids

Completely dissociates in water.

You will need to remember these three:

HCl

H_2SO_4

HNO_3

Name 'Em!

HF

HCl

H_2SO_4

HNO_3

HIO_3

Which are strong acids?

Bases

A chemical species that donates hydroxide ions (OH^-) or that accepts protons.

Have a bitter taste.

Feel slippery. Many soaps contain bases.

Some Properties of Bases

Produce OH^- ions in water

Taste bitter, chalky

Are electrolytes

Feel soapy, slippery

Name these Common Bases

NaOH	Drain cleaner
KOH	Liquid soap
$Ba(OH)_2$	Stabilizer for plastics
$Mg(OH)_2$	Milk of magnesia
$Al(OH)_3$	Maalox (antacid)

Naming Bases

Group I metals all form strong bases with hydroxide

Same name as chemical name

Ex. NaOH – Sodium hydroxide

List the rest of them (write their names and chemical formulas)

KNOW THEM

Recall…

In your own words define:

- What an acid and base are,
- How can you distinguish them,
- How do you name them

Bell Work
25.April.2018

Name the following acids and bases:

CsOH

HBr

HNO_2

Write the correct formula for the following acid and bases

Ammonia

Acetic Acid

Carbonic Acid

Hydroiodic Acid

Introduction to pH

PhET Simulation on class website under labs

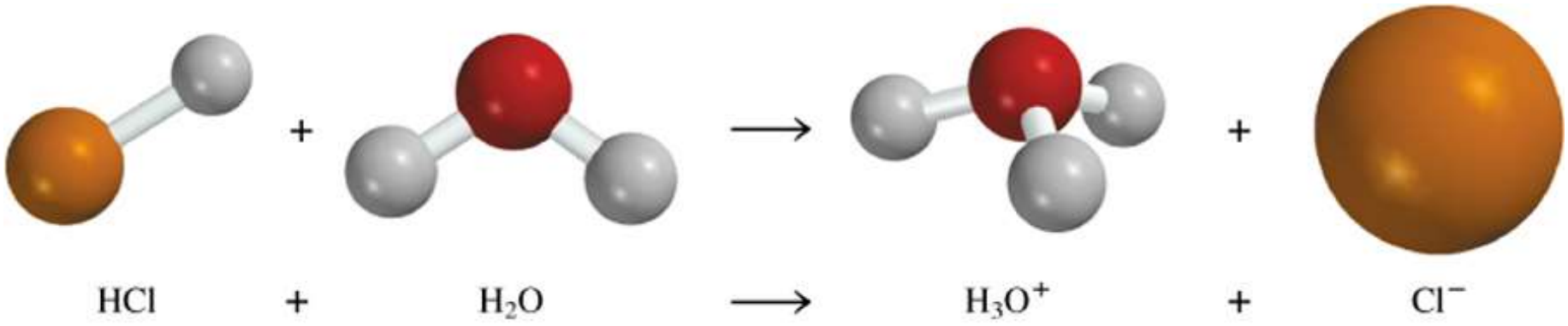
“Under Standing pH”

Due 30April2018

Visual Introduction to Acid Base Chemistry

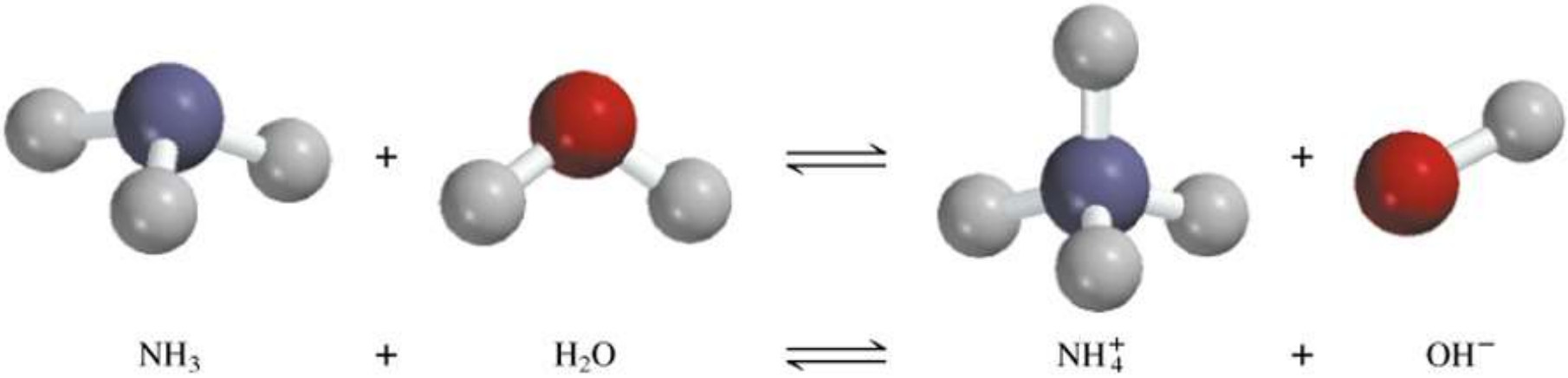
Complete one more section B, C, or D today

Arrhenius acid: "is a substance that produces H^+ (H_3O^+) in water"



$HCl + H_2O \rightarrow H_3O^+ + Cl^-$

Arrhenius base: "is a substance that produces OH^- in water"



$$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$$

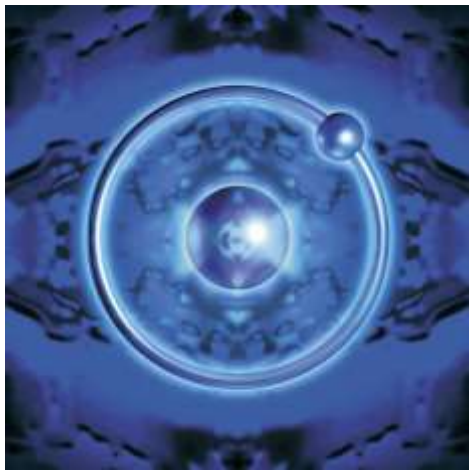
Acid/Base Definitions

Definition #2 Brønsted – Lowry

Acids – proton donor

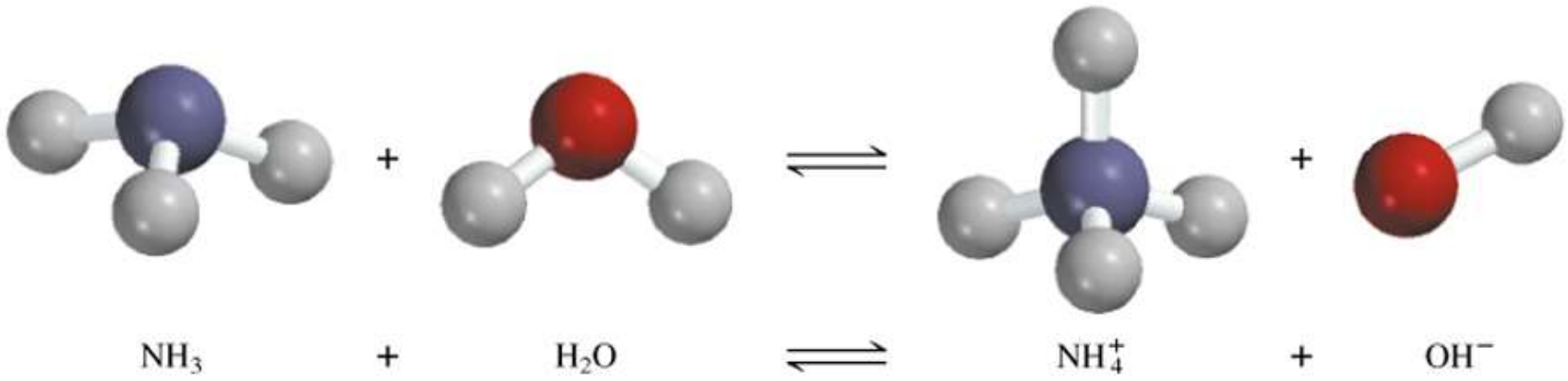
Bases – proton acceptor

A “proton” is really just a hydrogen atom that has lost it’s e^-!



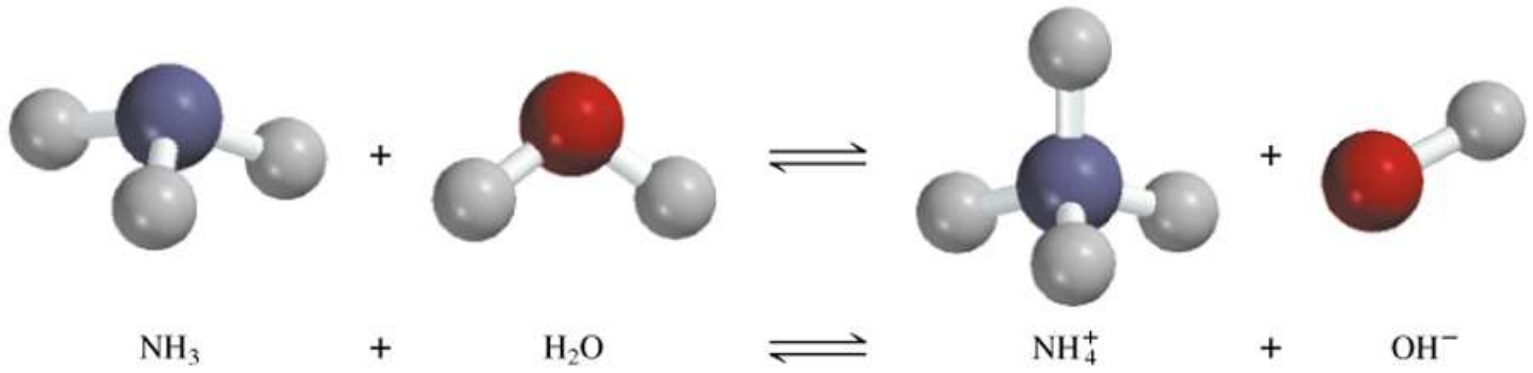
A Brønsted-Lowry acid is a proton donor

A Brønsted-Lowry base is a proton acceptor



NH_3 + H_2O → NH_4^+ + OH^-

base acid conjugate acid conjugate base



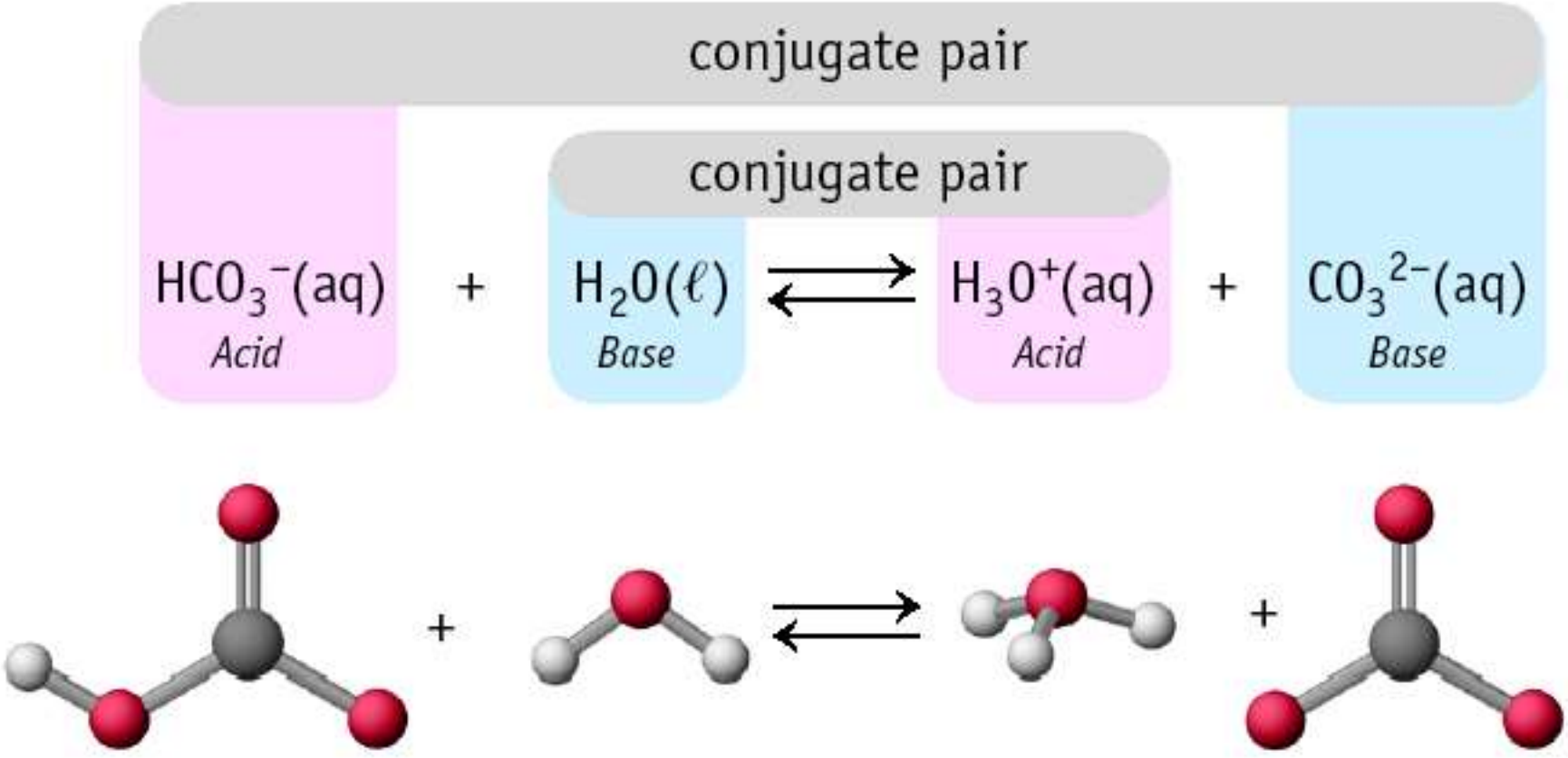
$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

base **acid** **conjugate acid** **conjugate base**

conjugate acid: substance formed when base gains a hydrogen ion

conjugate base: substance formed when an acid loses a hydrogen ion

Conjugate Pairs



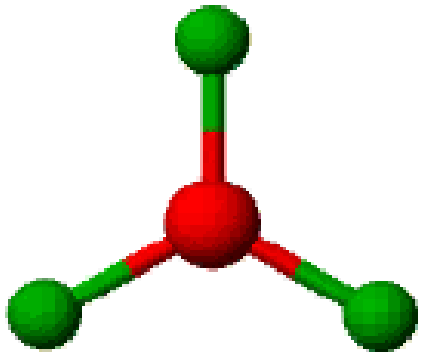
Suggested Practice Homework

Read 574-576, and #1-2

Acids & Base Definitions

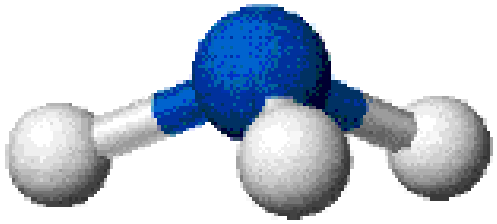
Definition #3: Lewis

Lewis acid - a substance that accepts an electron pair



BF_3, the boron atom is surrounded by only three electron pairs.

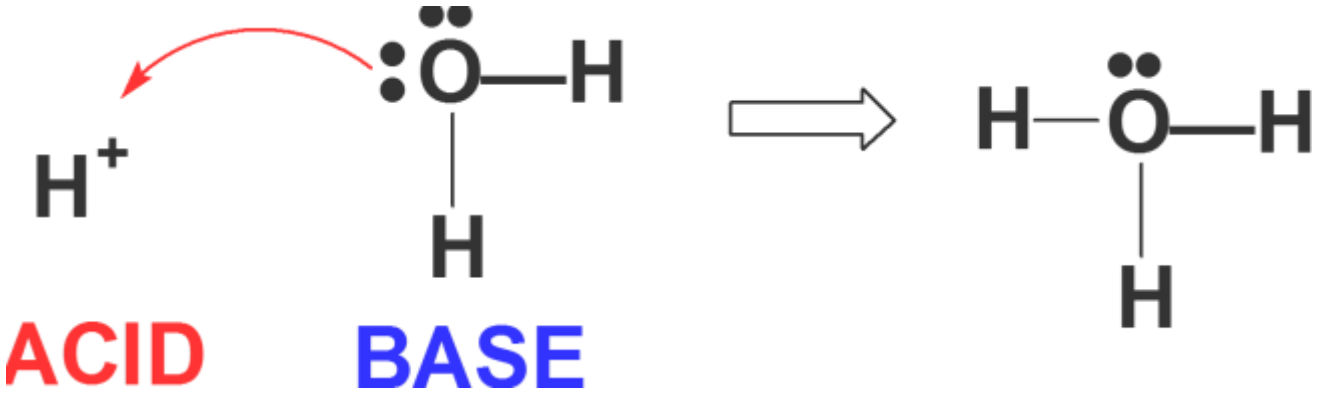
Lewis base - a substance that donates an electron pair



NH_3, the N atom has three bond pairs and one lone pair of electrons.

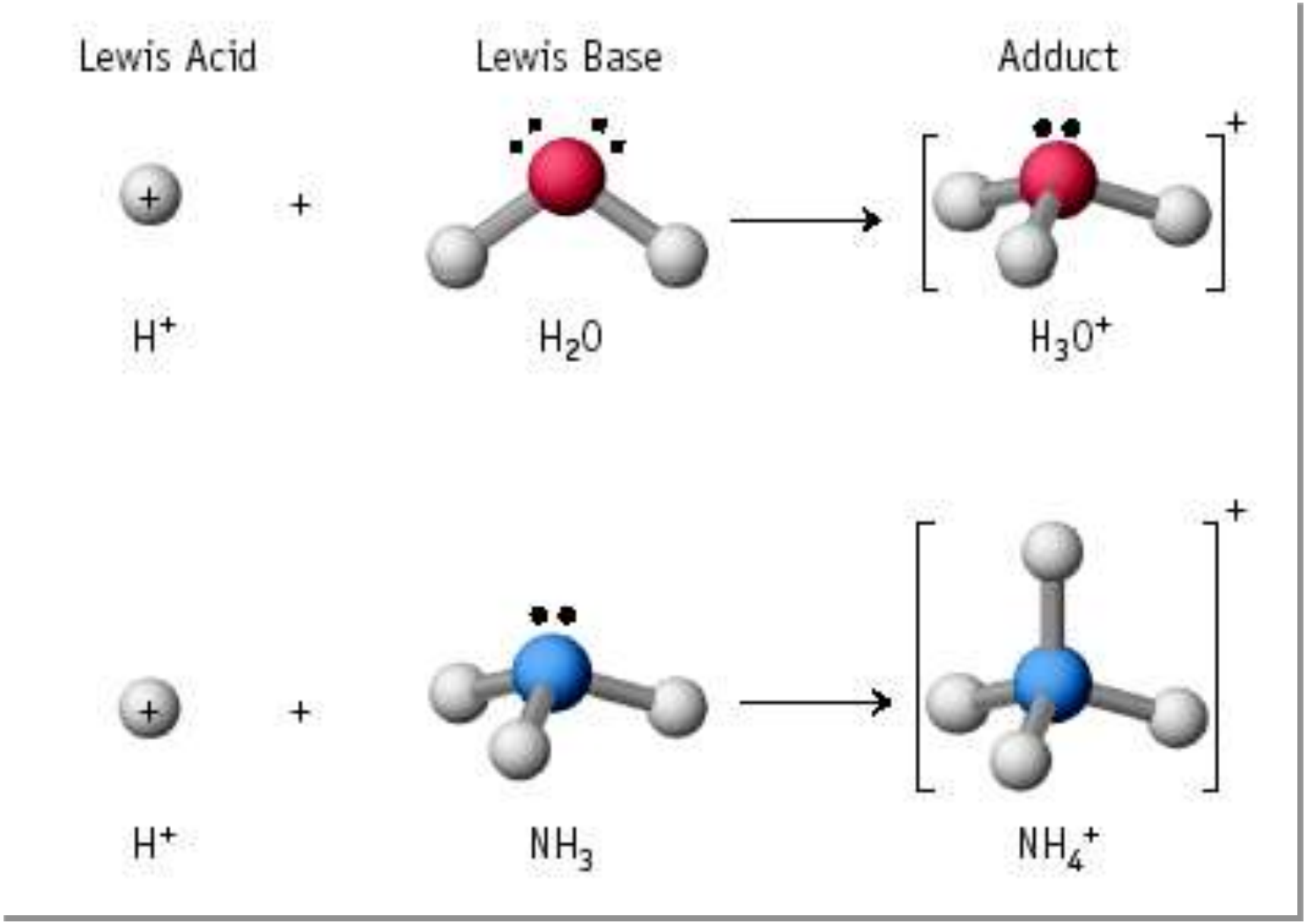
Lewis Acids & Bases

Formation of hydronium ion is also an excellent example.



Electron pair of the new O-H bond originates on the Lewis base.

Lewis Acid/Base Reaction



Learning Check!

Label the acid, base, conjugate acid, and conjugate base in each reaction:

$HCl + OH^- \rightarrow Cl^- + H_2O$

$H_2O + H_2SO_4 \rightarrow HSO_4^- + H_3O^+$

For most Acid Bases Rxns

The generic equation for most acid base rxn is:

$$HA + BOH \rightarrow BA + H_2O$$

You will get a salt and water out of an acid base rxn!

You try… write out the products:

$HA + BOH \rightarrow BA + H_2O$

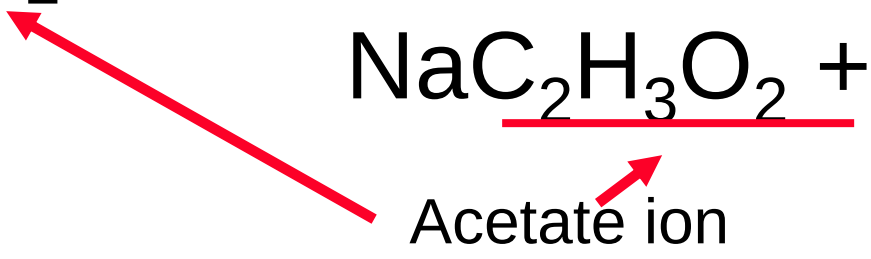
You will get a salt and water out of an acid base rxn!

1) $HCl + NaOH \rightarrow NaCl + H_2O$

2) $HNO_3 + KOH \rightarrow KNO_3 + H_2O$

3) Tricky $HC_2H_3O_2 + NaOH \rightarrow$

$NaC_2H_3O_2 + H_2O$



What volume of a 1.420 *M* NaOH solution is required to titrate 25.00 mL of a 4.50 *M* H_2SO_4 solution?

WRITE THE BALANCED CHEMICAL EQUATION!

$$H_2SO_4 + 2NaOH \longrightarrow 2H_2O + Na_2SO_4$$

volume acid $\xrightarrow{M\text{ acid}}$ moles acid $\xrightarrow{\text{Mole Bridge}}$ moles base $\xrightarrow{M\text{ base}}$ volume base

$$25.00\ \text{mL} \times \frac{4.50\ \text{mol}\ H_2SO_4}{1000\ \text{mL soln}} \times \frac{2\ \text{mol NaOH}}{1\ \text{mol}\ H_2SO_4} \times \frac{1000\ \text{ml soln}}{1.420\ \text{mol NaOH}} = 158\ \text{mL}$$

Suggested Practice Homework

Read 580, and #9-12

Bell Work
26-April-18

What are the strong acids you must know?

What is the conjugate base in the reaction below?

$HC_2H_3O_2 + H_2O \rightarrow H_3O^+ + C_2H_3O_2^-$

What do bases taste like?

Agenda

Acid base definitions

pH

Objective:

You will be able to describe the pH scale.

For most Acid Bases Rxns

The generic equation for most acid base rxn is:

$$HA + BOH \rightarrow BA + H_2O$$

You will get a salt and water out of an acid base rxn!

Recap!

Identify the acid, base, and conjugate acid and base in each equation:

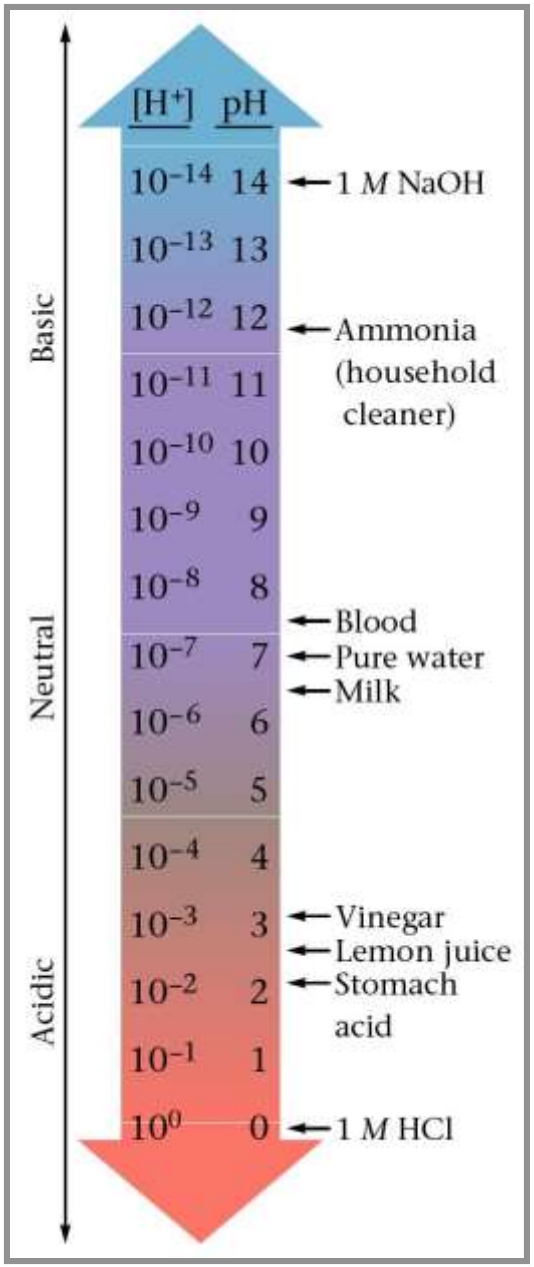
$$H_2SO_4 + H_2O \rightarrow HSO_4^- + H_3O^+$$

pH scale = way of expressing the strength of acids & bases. Instead of using very small #'s, we just use the NEGATIVE power of 10 on the Molarity of the H^+ (or OH^-) ion.

Under 7 = acid

7 = neutral

Over 7 = base



pH of Common Substances

Figure 5.17 **pH values of some common substances.** Here the "bar" is colored red at one end and blue at the other. These are the colors of litmus paper, commonly used in the laboratory to decide if a solution is acidic (litmus is red) or basic (litmus is blue). *(Charles D. Winters)*

Bell Work
3-May-18

You should know these:

i. What is pH (define and explain)?

ii. An Acid?

iii. A base?

Bonus:

i. What is the $[H^+]$ concentration of a solution with a pH of 8.1?

ii. What is a Brønsted – Lowry base?

Agenda

pH recap

pOH

pH → $[H^+]$ → $[OH^-]$ → pOH Flow Chart

Objective: **You will be able to interconvert between pH → $[H^+]$ → $[OH^-]$ → pOH.**

I should be able to… (objectives mastered by end of class 3May18)

Explain the pH scale:

- Logarithmic power of 10
- Potential of H^+, greater the $[H^+]$ = smaller pH
- Greater $[OH^-]$ = larger pH
- $[H^+] = [OH^-]$: neutral solution, pH of 7

All strong acid and bases fully dissociate (100% ionization)

Define an acid (HA): Generally produces H^+ (H_3O^+ when H_2O is included in rxn, we will treat H^+ and H_3O^+ and as something),

- [strong acids] =$[H^+]$ (you must memorize these HCl, HNO_3, H_2SO_4)
- pH<7

Define an base (BOH): Generally produces or increase $[OH^-]$

- [strong base] =$[OH^-]$ (memorize these all group I metal hydroxides)
- pH>7

Interconvert between **pH, $[H^+]$, $[OH^-]$,** and **pOH** with aid of pH flow chart

Calculating the pH

$pH = - \log [H^+]$

$pH = - \log [H_3O^+]$

(Remember that the [ ] mean Molarity)

Example: If $[H^+] = 1 \times 10^{-10}$

$pH = - \log 1 \times 10^{-10}$

$pH = - (- 10)$

$pH = 10$

For a strong acid [H+] ~ the molarity of the solution

Calculating the pH

pH = - log [H+]

(Remember that the [ ] mean Molarity)

Example: If $[H^+] = 1.8 \times 10^{-5}$

pH = - log 1.8×10^{-5}

pH = - (- 4.74)

pH = 4.74

Try These!

Find the pH of these:

1) A 0.15 M solution of Hydrochloric acid

2) A 3.00 x10^{-7} M solution of Nitric acid

3) A 6.0M solution of Sulfuric acid

pH Cals. Solving for [H+]

If the pH of Coke is 3.12, [H+] = ???

Because pH = - log [H+] then

- pH = log [H+]

Take antilog (10^x) of both sides and get

$$10^{-pH} = [H^+]$$

$$[H^+] = 10^{-3.12} = 7.6 \times 10^{-4}\ M$$

***** to find antilog on your calculator, look for "Shift" or "2nd function" and then the "log" button**

Practice

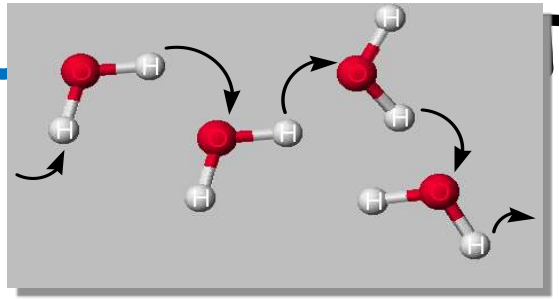
What is the pH of a solution with a proton concentration of 0.032 M?

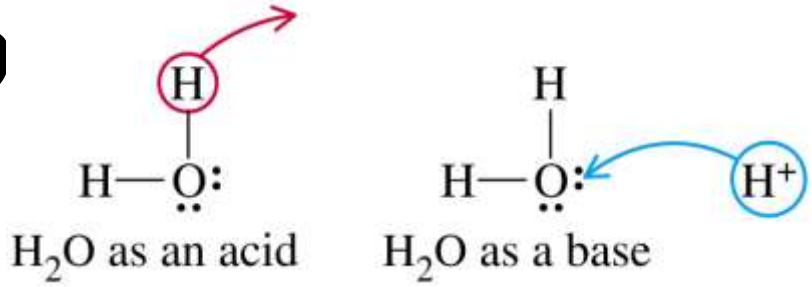
What is the proton concentration in a solution with pH of 9.24?

More about Water

H_2O can act as both an ACID & a BASE.

In pure water there can be





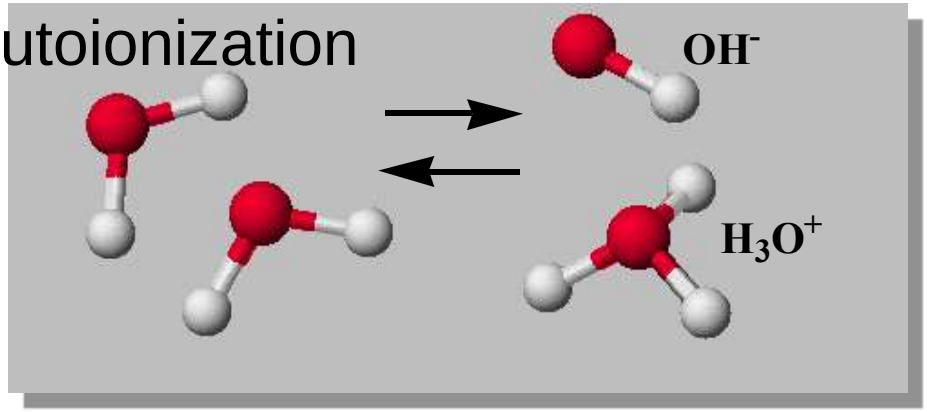
H_2O as an acid H_2O as a base

Equilibrium constant for water = K_w

$K_w = [H_3O^+]\,[OH^-] =$

$K_w = [H^+]\,[OH^-] = 1.00 \times 10^{-14}$ at 25 °C

More about Water



K_w = $[H_3O^+]$ $[OH^-]$ = 1.00 x 10^{-14} at 25 °C

In a neutral solution $[H_3O^+]$ = $[OH^-]$

so K_w = $[H_3O^+]^2$ = $[OH^-]^2$

and so $[H_3O^+]$ = $[OH^-]$ = 1.00 x 10^{-7} M

pOH

Since acids & bases are opposites, pH and pOH are opposites!

pOH does not really exist, but it is useful for changing bases to pH.

$$\underline{pOH = -\log [OH^-]}$$

Since pH and pOH are on opposite ends of scale,

$$pH + pOH = 14$$

$\mathcal{K}_w$

Water dissociation constant; K_w.

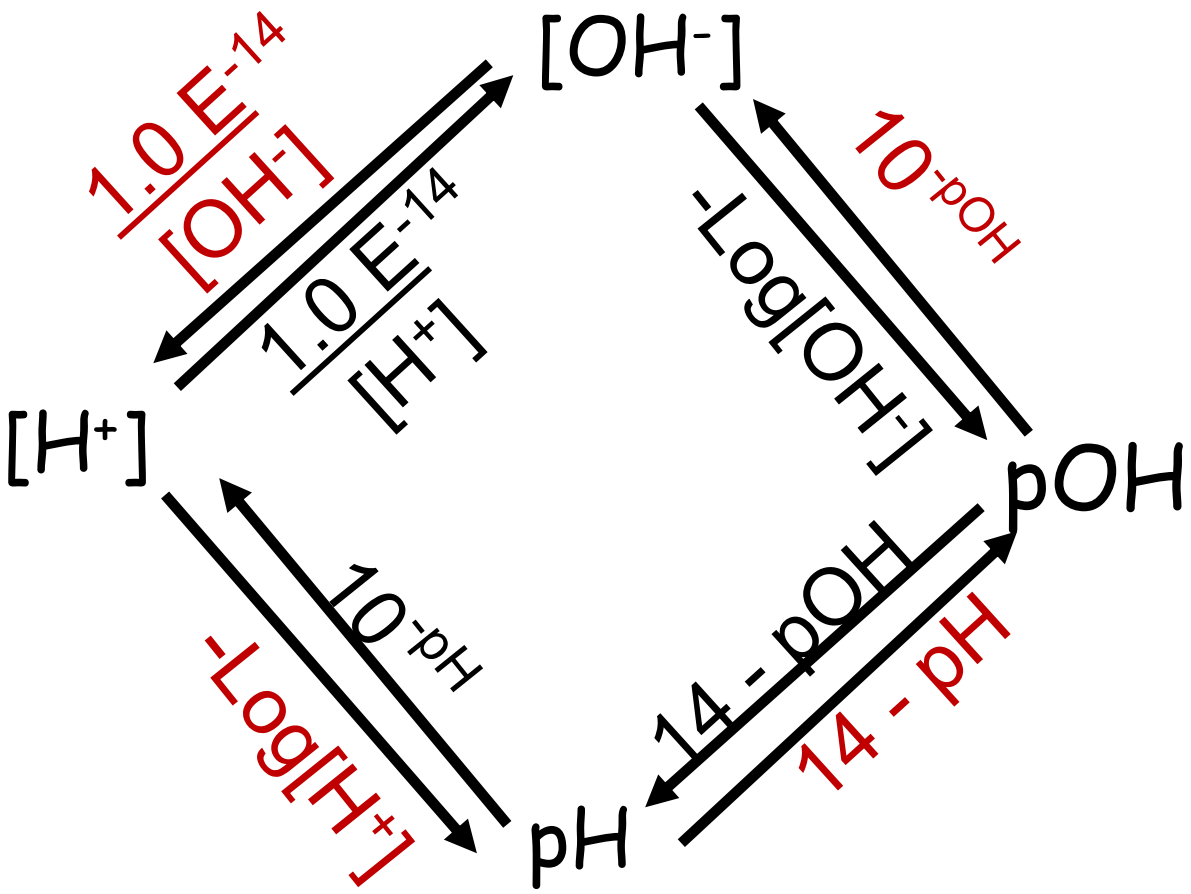
$K_w = 1.0 \times 10^{-14}$

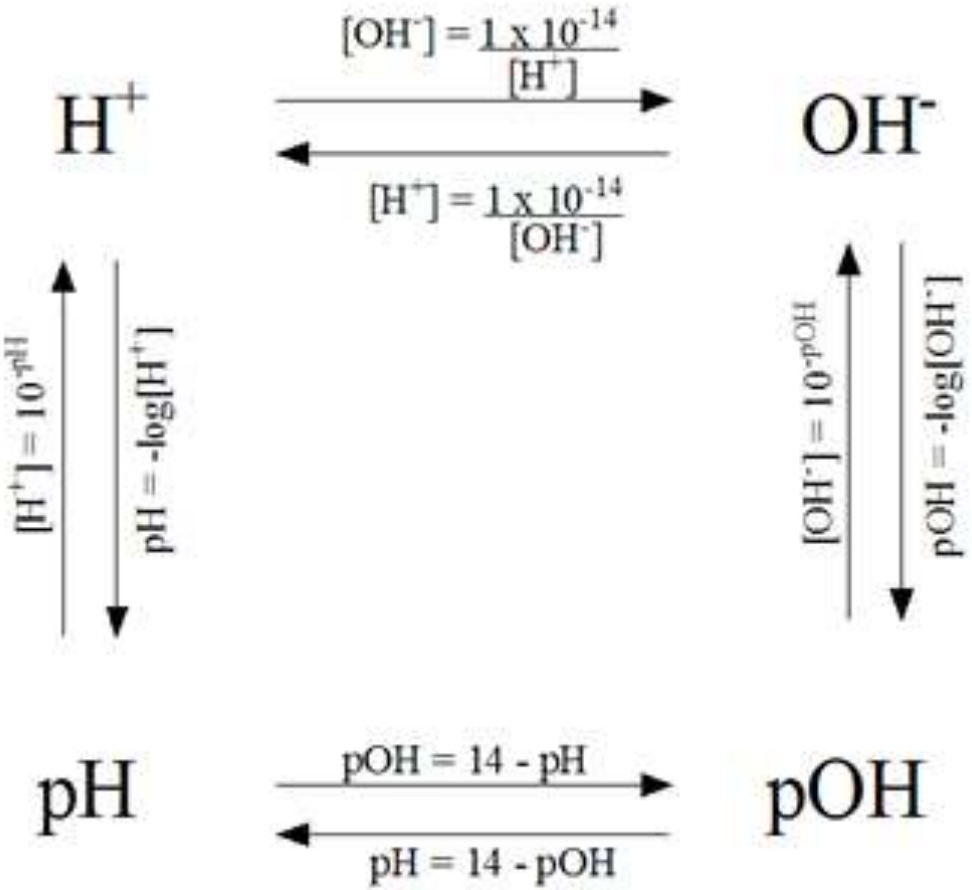
$K_w = [H^+][OH^-]$

$1.0 \times 10^{-14} = [H^+][OH^-]$

Or

$$K_w = [H_3O^+]\,[OH^-] = 1.00 \times 10^{-14}$$


[OH-]
[H+]
pOH
pH
1.0 E-14 / [OH-]
1.0 E-14 / [H+]
10-pOH
-Log[OH-]
10-pH
-Log[H+]
14 - pOH
14 - pH


$[OH^-] = \frac{1 \times 10^{-14}}{[H^+]}$
H^+
OH^-
$[H^+] = \frac{1 \times 10^{-14}}{[OH^-]}$
$[H^+] = 10^{-pH}$
$pH = -\log[H^+]$
$[OH^-] = 10^{-pOH}$
$pOH = -\log[OH^-]$
pH
pOH = 14 - pH
pH = 14 - pOH
pOH

Homework 3May18

Finish pH and pOH Calculations Practice #1,

Table on front page due 3May18 start of class

Bell Work 3.May.2018

A student dilutes concentrated hydrochloric acid to make two solutions:
(a) 3.0 *M*
(b) 0.0024 *M*.

Calculate the $[H^+]$, pH, $[OH^-]$, and pOH of the two solutions at 25°C.

EQ:
Why is pH so misunderstood?

Objective

Are you up to speed?

pH, [H+], etc. calculation Recap

Acid Nomenclature Review

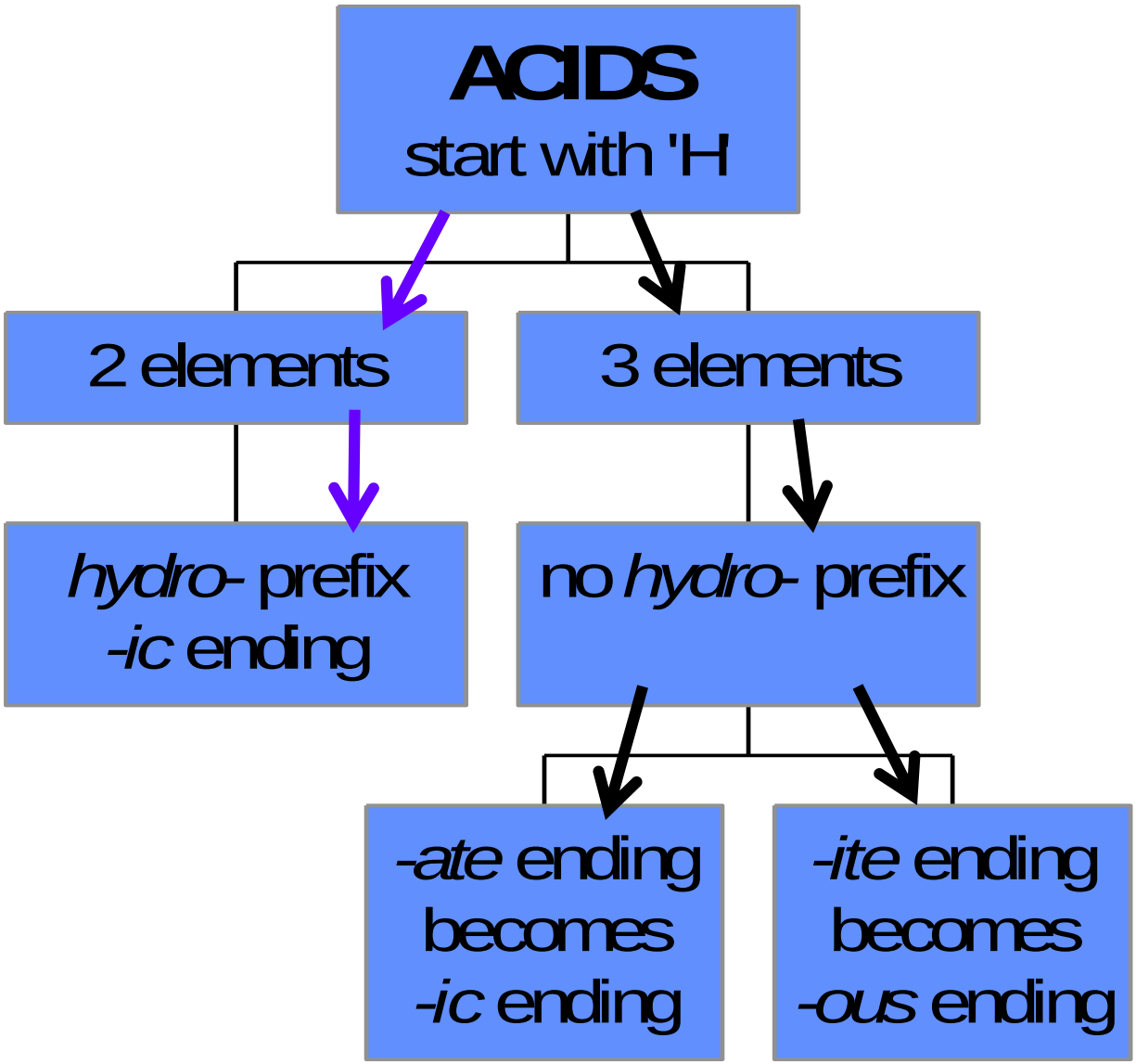
Anion Ending	Acid Name
Binary → *-ide*	*hydro-*(stem)*-ic acid*
Ternary → *-ate*	(stem)*-ic acid*
Ternary → *-ite*	(stem)*-ous acid*

Acid Nomenclature Review

An easy way to remember which goes with which…

"In the cafeteria, you ATE something ICky"

Acid Nomencl Flowch



Acid Nomenclature Review

$HBr_{(aq)}$ $\Rightarrow$ hydrobromic acid

H_2CO_3 $\Rightarrow$ carbonic acid

H_2SO_3 $\Rightarrow$ sulfurous acid

Strong Acids

Completely dissociates in water.

You will need to remember these three:

HCl

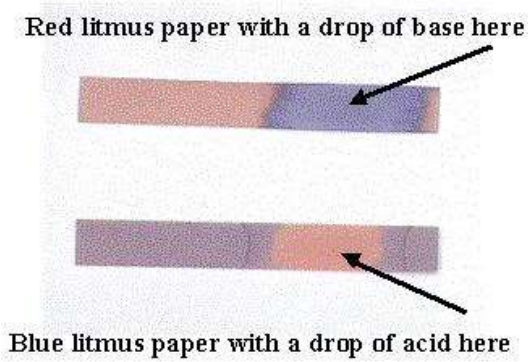
H_2SO_4

HNO_3

pH testing

There are several ways to test pH

- Blue litmus paper (red = acid)
- Red litmus paper (blue = basic)
- pH paper (multi-colored)
- pH meter (7 is neutral, <7 acid, >7 base)
- Universal indicator (multi-colored)
- Indicators like phenolphthalein
- Natural indicators like red cabbage, radishes



Paper testing

Paper tests like litmus paper and pH paper

- Place a drop of the solution from the end of the stirring rod onto a piece of the paper
- Read and record the color change. Note what the color indicates.
- You should only use a small portion of the paper. You can use one piece of paper for several tests.

pH paper

Behavior of Salts in Water

Table 18.8 The Behavior of Salts in Water

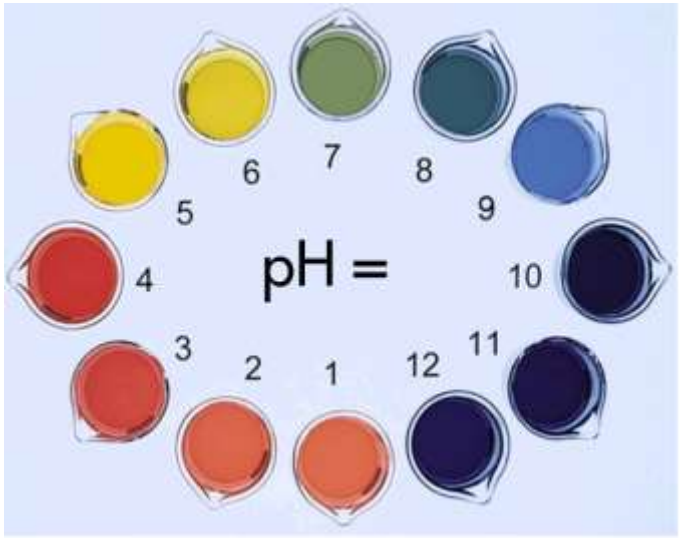
Salt Solution (Examples)	pH	Nature of Ions	Ion That Reacts with Water	
Neutral [NaCl, KBr, $Ba(NO_3)_2$]	7.0	Cation of strong base Anion of strong acid	None	
Acidic [NH_4Cl, NH_4NO_3, CH_3NH_3Br]	<7.0	Cation of weak base Anion of strong acid	Cation	
Acidic [$Al(NO_3)_3$, $CrCl_3$, $FeBr_3$]	<7.0	Small, highly charged cation Anion of strong acid	Cation	
Basic [CH_3COONa, KF, Na_2CO_3]	>7.0	Cation of strong base Anion of weak acid	Anion	

pH meter

- Tests the voltage of the electrolyte
- Converts the voltage to pH
- Very cheap, accurate
- Must be calibrated with a buffer solution

pH indicators

- **Indicators are dyes that can be added that will change color in the presence of an acid or base.**
- **Some indicators only work in a specific range of pH**
- **Once the drops are added, the sample is ruined**
- **Some dyes are natural, like radish skin or red cabbage**



Bell Work 7May2018

Write the balance equation for sodium hydroxide reaching with hydrochloric acid.

If 10.0mL of sodium hydroxide is reacted (neutralized) with 25.0mL of 0.05M hydrochloric acid, what is the concentration of the sodium hydroxide?

EQ:
Why is pH so misunderstood?

Objective

You will be able to set up a burette and dispense specific quantities of analyite to a reaction flask

Titrations; Setting up Burette

1. Attach to ring stand using burette clamp

2. Open burette and rinse with DI water into a waste beaker.

3. Close burette after all DI water and drained through run2-5mL of through burette to coat sides.

4. Close burette and load titrant, run just enough titrant through burette to remove all air bubbles from spout.

Titrant; what you know (known concentrations)

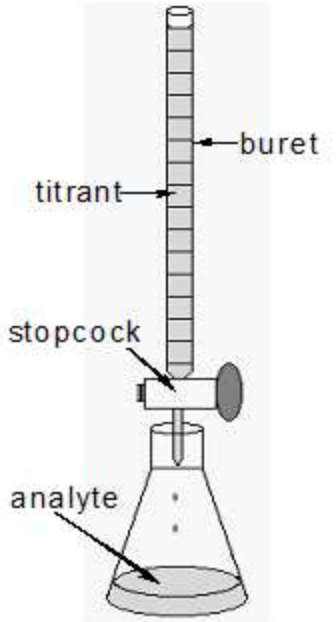


Figure 1: Titration Setup

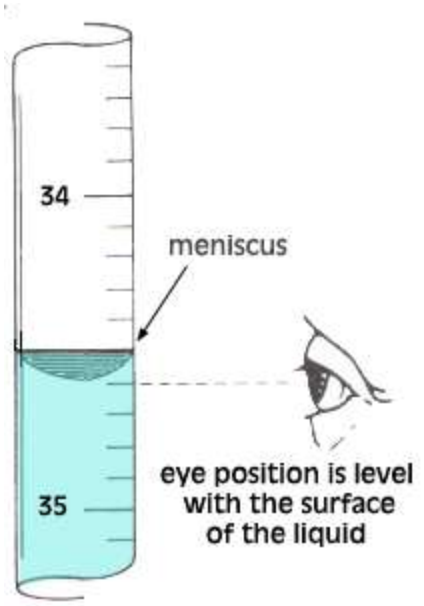
Analyte; what you are trying to find

Titrations, Reading a Burette:

Make sure burette is level.

5. Record initial volume by reading bottom of meniscus

6. After titration is complete, read final volume and record.



	Trial 1	**Trail 2**
Vol $_{initial}$		
Vol $_{Final}$		
Vol $_{dispensed}$		

Titrations

I. Practice rinsing burette and setting up for use.

II. Load burette with titrant (just water today)

III. Add known amount of analyte to a Erlenmeyer Flask (just water today)

IV. Each person: Practice dispensing titrant in amounts of 10ml, 5mL, 2mL, 1mL, and 0.1mL.

V. Clean up, always leave burette in the open position and make sure you have rinsed 2-3x with DI water!

Acid Base Titration Calculations

Recall our dilution formula

$$M_1V_1 = M_2V_2$$

M = Molarity (mol/L)

V = Volume (L)

Think of it like this:

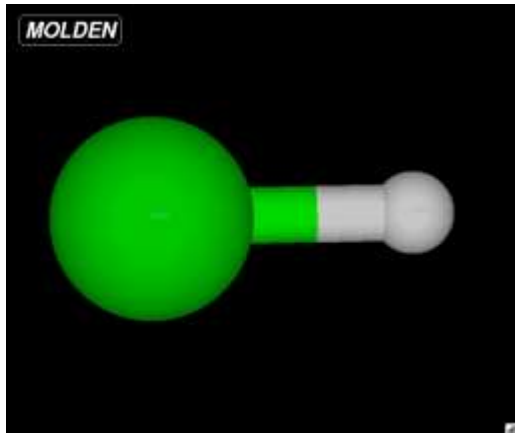
$$M_{acid}V_{acid} = M_{base}V_{base}$$

Acid Base Rxn Titration

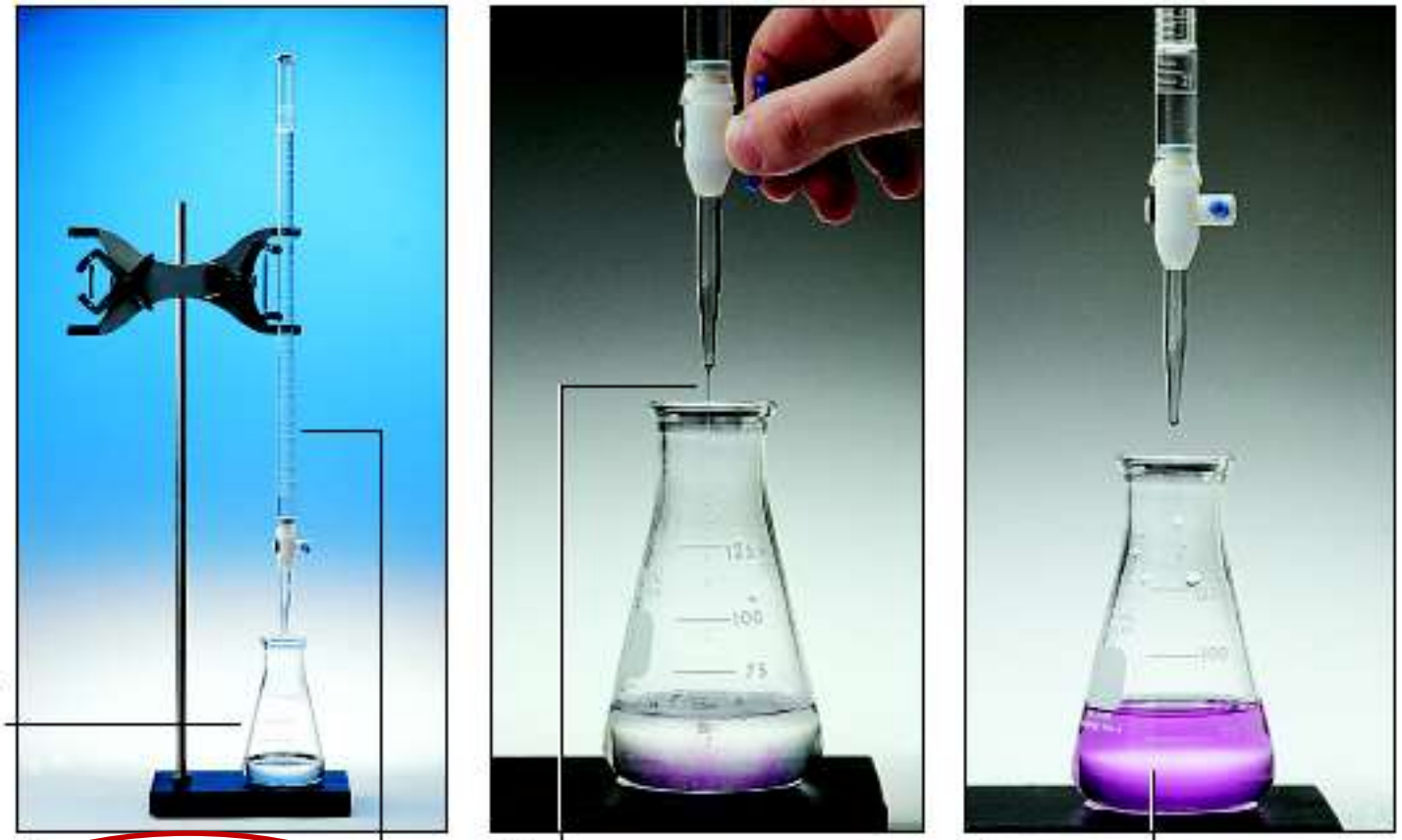
$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

acid base

Carry out this reaction using a TITRATION.



Setup for titrating an acid w/ a base



Practice

When ammonia reacts with water an ammonium ion and hydroxide is produced.

-Write a balanced equations.

-What type of base is ammonia if it is producing hydroxide?